PORTAGE CREEK MODELING SUMMARY

for

PERFORMANCE PAPER SITE
Site ID 39000140
401 ALCOTT STREET
KALAMAZOO, MICHIGAN 49001

Prepared For:

URS Corporation
34555 West Twelve Mile Road
Farmington Hills, Michigan 48331

&

Michigan Department of Environmental Quality
Kalamazoo District Office
7953 Adobe Rd
Kalamazoo, MI 49009-5026

Prepared By:

Environmental Consulting & Technology, Inc.
2250 Genoa Business Park Drive
Suite 130
Brighton, Michigan 48114

December 2005

Introduction

This study was carried out to ascertain the extent of the hundred year floodplain of a section of the Portage Creek, a tributary of the Kalamazoo River, located in Kalamazoo County, Michigan. The study focuses on predicting the hundred year flood water-surface elevation under the proposed design. Existing conditions consist of a concrete rectangular channel, which captures the entire hundred year flow. Existing conditions will not be modeled in this study due to the fact that the proposed design uses natural channel design concepts, which substantially deviates from existing conditions, and therefore the existing conditions will not be useful for comparative purposes.

This memo summarizes the hydraulic modeling efforts performed by Environmental Consulting & Technology, Inc. (ECT) for the proposed Portage Creek located between E. Alcott Road (upstream) and Reed Avenue (downstream), Section 27, T.2S., R.11W., City of Kalamazoo, Kalamazoo County, Michigan. See provided construction plans for the design of the proposed watercourse and site details.

Modeling Inputs

The Hydrologic Engineering Center River Analysis System (HEC-RAS) version 3.1.3, May 2005 was used to perform the one-dimensional steady flow, stream hydraulics calculations. The steady flow water surface profile component of HEC-RAS is designed for applications in floodplain management and flood insurance studies, and can predict the water surface elevation of multiple flood events.

Stormwater Discharge Estimates

The Land and Water Division of the Michigan Department of Environmental Quality (MDEQ) is authorized to compute and provide discharge rates for surface water streams in the State. In this particular study, the MDEQ was requested to compute the discharge rates for the site at Bryant Street, approximately 600 feet downstream of E. Alcott Road. The discharge estimates were received by ECT via email on November 9, 2005. The following is the email received by ECT (flows are summarized in Table 1-1):

> -----Original Message-----
> From: DEQ-LWM-QREQ DEQ-LWM-QREQ [mailto:deq-lwm-qreq@michigan.gov]
> Sent: Wednesday, November 09, 2005 1:10 PM
> To: ccreech@ectinc.com
> Subject: Re: Discharge Request
>
> This reply is being sent via email only.
>
> We have estimated the flood frequency discharges requested in your phone call of October 14, 2005 (Process No. 20050560), as follows:
>
> Portage Creek at Bryant Street, Section 27, T2S, R11W, City of Kalamazoo, Kalamazoo County, has a total drainage area of 47.7 square miles and a contributing drainage area of 27.1 square miles. The 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% chance peak flows are estimated to be 80 cubic feet per second (cfs), 160 cfs, 220 cfs, 320 cfs, 410 cfs, 500 cfs, 600 cfs, and 750 cfs, respectively. (Watershed Basin No. 17 Kalamazoo).
>
> Please include a copy of this letter with your application for permit. These estimates should be confirmed by our office if an application is not submitted

within one year. If you have any questions concerning the discharge estimates, please contact Mr. Richard Sorrell, Hydrologic Studies Unit, at 517-335-3176 or by email to orrel@michigan.gov. Any questions concerning the hydraulics or the proper procedure for filing for a permit should be directed to Ms. Carrie Wontorcik, Land and Water Management Division, Kalamazoo District Office, at 269-567-3564 or email to wontorcc@michigan.gov.

Sincerely,

Richard C. Sorrell, P.E., Chief
Hydrologic Studies Unit
Land and Water Management Division

Table 1-1: MDEQ's Estimates of Peak Discharges in Cubic Feet Per Second Used in the Present Study

Return Period	Discharge	Source
2-year (50%)	80 cfs	MDEQ
5-year (20%)	160 cfs	MDEQ
10-year (10%)	220 cfs	MDEQ
25-year (4%)	320 cfs	MDEQ
50-year (2%)	410 cfs	MDEQ
100-year (1%)	500 cfs	MDEQ
200-year (0.5%)	600 cfs	MDEQ
500-year (0.2%)	750 cfs	MDEQ
Low-Flow	30 cfs	ECT Estimate

Friction Coefficient

The friction value for the channel was selected based on the general description of "Natural Streams – Minor streams – Streams on plain – Clean, winding, some pools and shoals but some weeds and many stones". This corresponds to a friction value of 0.05 (Chow, 1959). The friction value for the floodplain was based on the general description of "Flood plains – Brush – Scatter brush, heavy weeds" and Chow lists the friction value of 0.05 for this description. This value was used for all designed cross sections in the model.

Contraction and Expansion Loss Coefficients

Contraction and expansion of flow due to changes in the cross-section is a common cause of energy losses within a reach (between two cross sections). Whenever this occurs, the loss is computed from the contraction and expansion coefficients specified on the cross-section data editor (HEC-RAS Hydraulic Reference Manual, 2002). Where the change in river cross section are abrupt, such as at the transitions of riffles and pools, the REC-RAS Hydraulic Reference Manual suggest contraction and expansion values of 0.3 and 0.5 respectively. Given the relatively abrupt changes between reaches, these values were used.

Upstream and Downstream Boundary Conditions

A critical depth boundary condition was selected at the upstream location. This is due to the dam structure at the upstream reach forcing a critical flow regime at the dam outlet. A normal depth that corresponds to a river slope of 0.5% was used for the downstream boundary condition. This slope is similar to field conditions downstream of the site, and does not create any backwater effect onto any upstream reaches during the hundred year flow event.

Proposed Cross Sections

Appendix A provides graphics for each cross section used in the model and the corresponding hundred year elevation. See also the provided construction plans for the design of these cross sections.

Model Output

Appendix A provides the HEC-RAS model output for all modeled flows. Moreover, a digital copy of the model has also been forwarded to the MDEQ office to analyze any specific condition. This section provides general outputs for the revised condition and focuses on the output of the hundred year flow condition.

Due to the natural channel design that was incorporated, floodwaters will overtop the banks during the hundred year flow. Figure 1-1 is a plot of the modeled Portage Creek under the hundred year flow, and Figure 1-2 is a plot of the water surface profile, bank profile, bottom elevation, and energy grade line for the entire reach of the Portage Creek that was modeled. Figure 1-3 is a plot of the modeled Portage Creek under the two-year flow. This plot shows that the entire two-year flow is within the proposed banks.

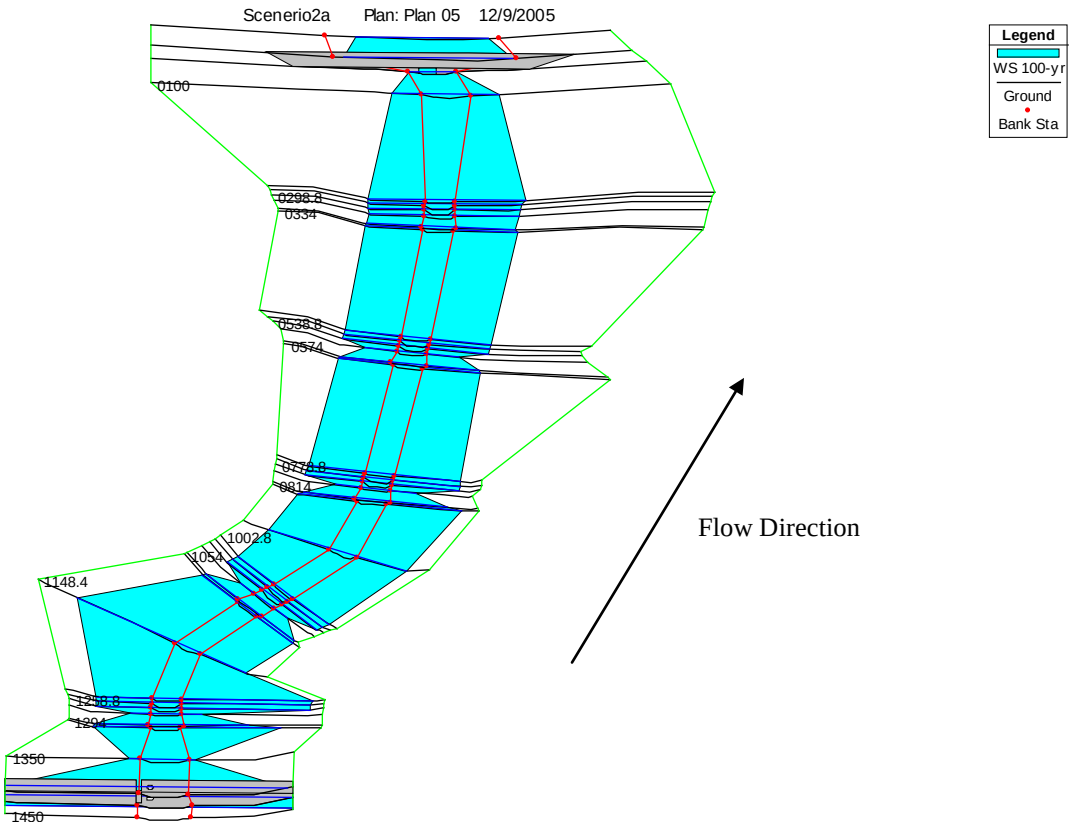

Figure 1-1: Three-dimensional depiction of the hundred-year flood water surface

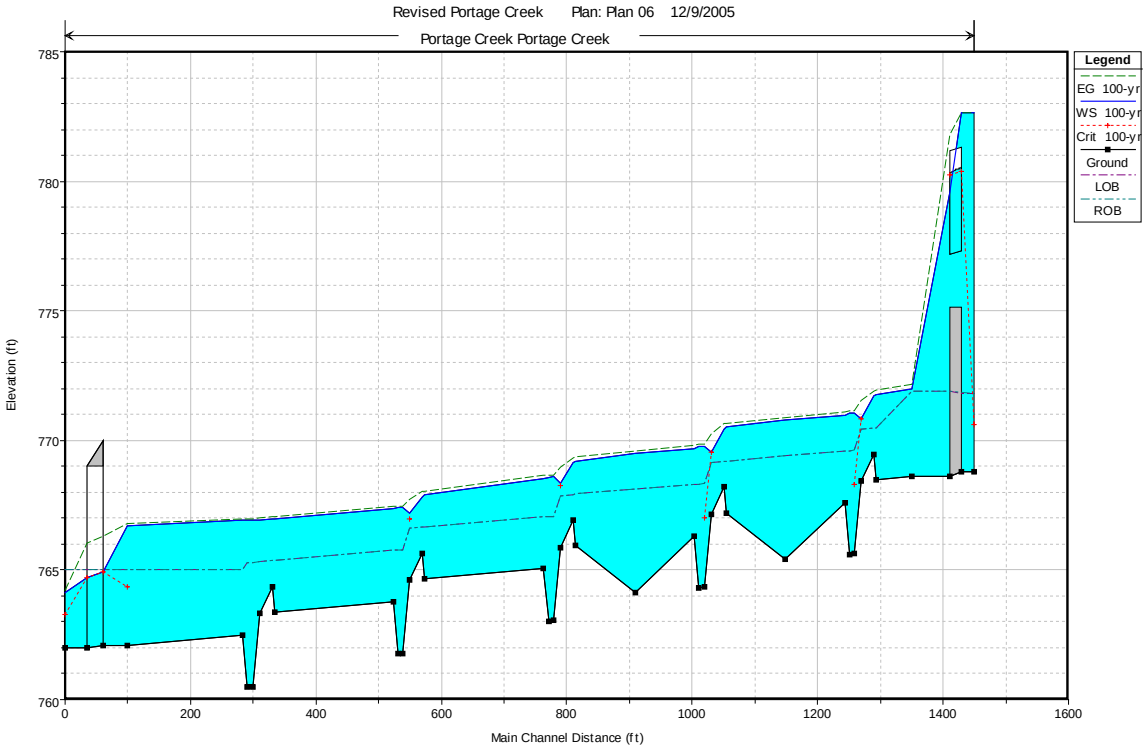

Figure 1-2: Longitudinal water surface elevation for modified channel conditions

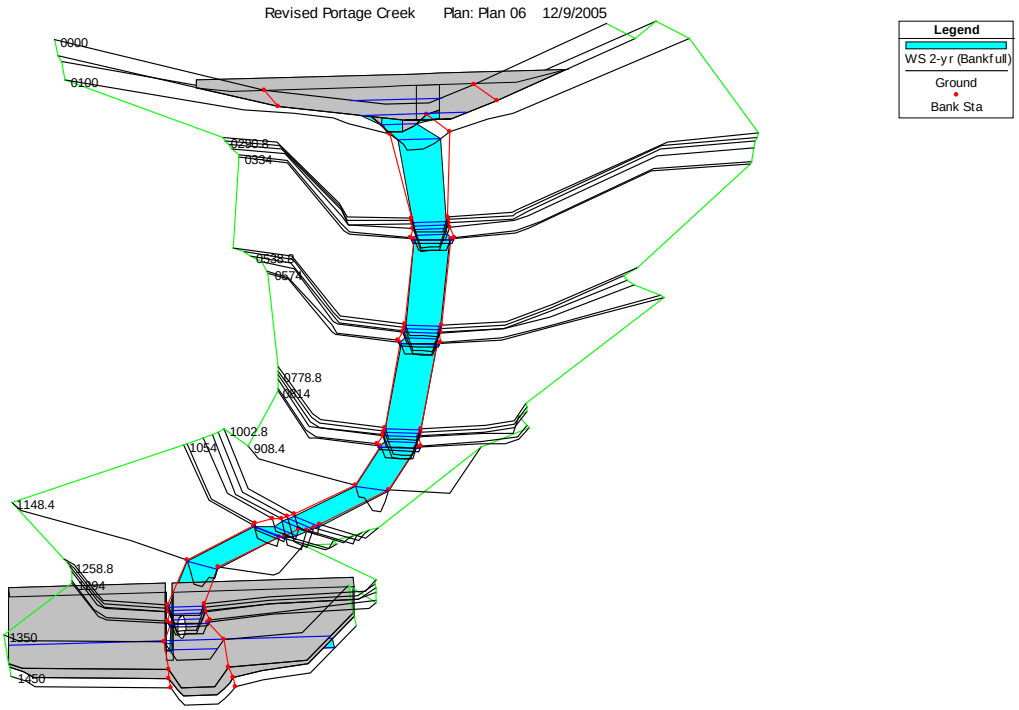

Figure 1-3 Three-dimensional depiction of the two-year flood water surface

The maximum velocities in the proposed channel occur at the riffle sections and approach 7 ft/sec at the four most upstream riffles during the hundred year flow. A plot of these velocities is shown in Figure 1-4.

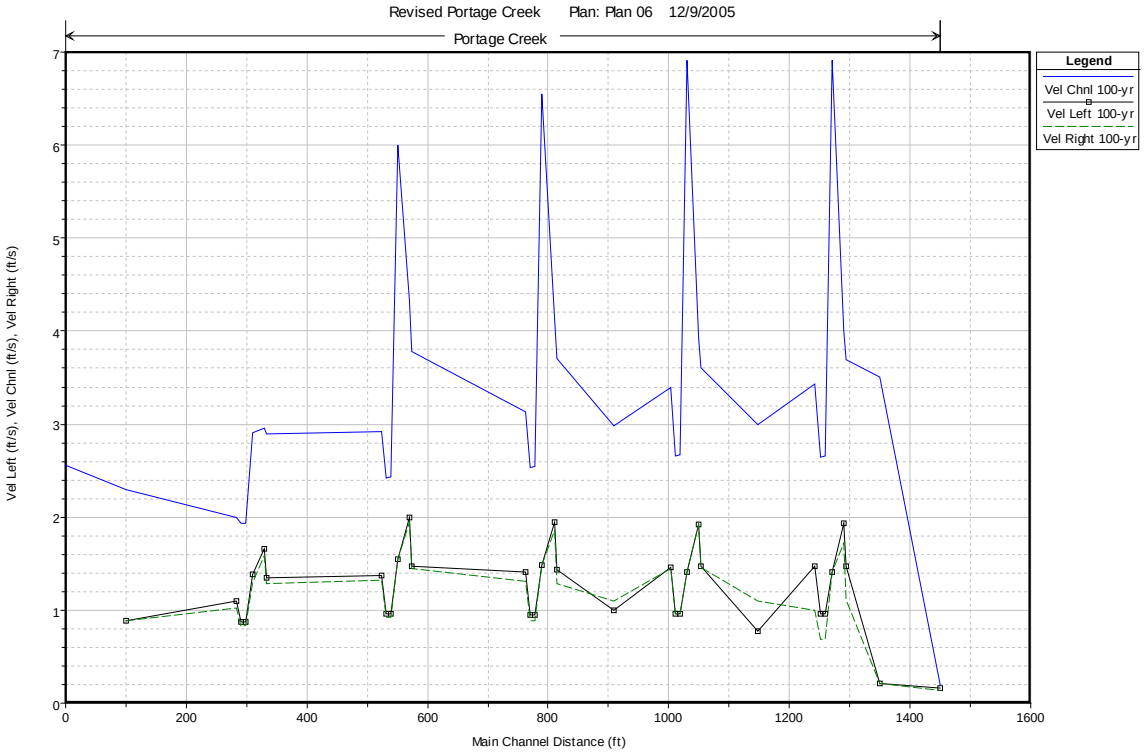

Figure 1-4 Longitudinal profile of channel velocities under the hundred year flow

The Froude number is a function of the channel's velocity and hydraulic depth. Critical flow occurs when the Froude number equal one. When the Froude number is less than one, then the flow regime is subcritical, and when greater than one, the regime is supercritical. At the three most upstream riffle sections, the Froude number is slightly greater than one, and therefore the flow regime transitions to supercritical. There will also likely be a supercritical flow regime just downstream of the dam, and then quickly transition to subcritical (this is also the case under the existing condition). Figure 1-5 shows the Froude number for the length of the stream under the hundred year flow.

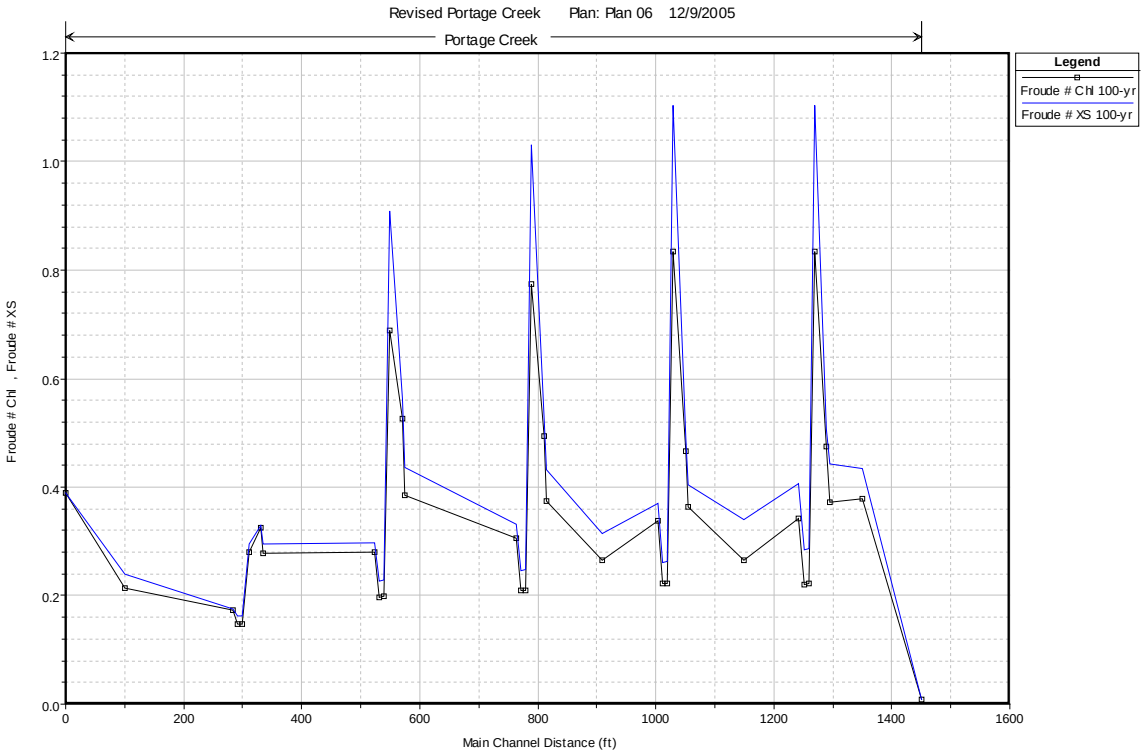

Figure 1-5: Longitudinal profile of Froude number under the hundred year flow

For additional model output of the hundred year flow condition as well as other model flows, see Appendix A.

Conclusions

It is the studied opinion of ECT that the proposed design will have the following hydraulic results on the Portage Creek between Reed Avenue and E. Alcott Road in Kalamazoo, Michigan:

- The hundred year floodwater surface elevation will be slightly lower than the existing condition on the site
- The stream will have an appearance of a natural channel, which includes riffles, glides, runs, and pools and will inundate the floodplain at high flow conditions.
- The banks will overtop at a flow that is approximately equal to the two-year flow condition.
- Maximum velocities occur at the riffle sections, and approach 7 ft/sec for the hundred year flow.
- During the hundred year flow, no flooding outside of the slope adjacent to the floodplain will occur, and this flow will be contained with the new designed floodplain.